VOL. 2 No. 4 April 1985

COMPUTERDIGEST

NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

THE NEW HIGH-SPEED MODEMS

How they work, how they evolved, all you need to know

A GERNSBACK PUBLICATION

RESONANT CIRCUIT DESIGN

Involved in designing resonant circuits? Let your computer do the work.

INEXPENSIVE IBM'S

Our cost-conscious Herb Friedman shows how to shave expenses

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- TWO 400K DSDD DRIVES
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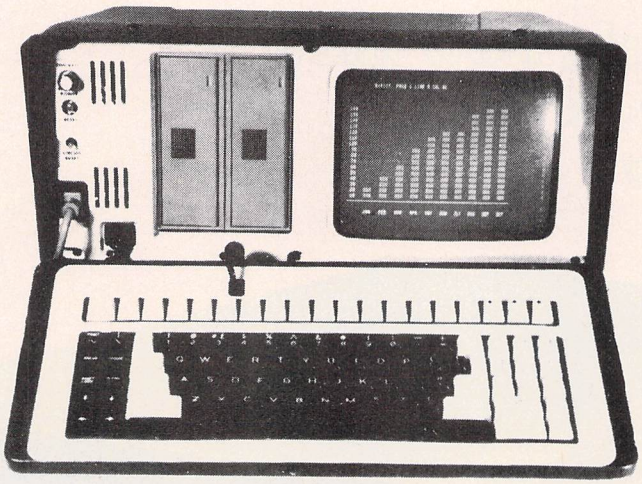
- M80 (L80, LIB80, CREF80)
- SOURCE CODE OF THE BIOS PLUS UTILITIES
- DATA COMMUNICATIONS SETUP PACKAGE
- SERIAL & PARALLEL PRINTER PORT
- DATA COMMUNICATION PORT



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General Specifications

ZORBA is the lowest cost full featured portable computer. This light weight computer is ruggedly packaged in a convenient carrying case. The case surrounds a strong inner chassis which further protects the Z80A based computer with its two double sided double density disk 400K drives, large easy to read 9'' display screen and well designed detachable keyboard.

ZORBA uses CP/M, the industry standard operating system, which means that a wide range of existing software is readily available to the user.

The ZORBA users manual covers operation of the unit, all supplied software and all interface and internal information. A system diskette is supplied with all system files and utilities. A second diskette contains the sources for all ZORBA software including BIOS, SETUP, FORMAT, and PATCH.

Keyboard

Keyboard communicates serially with CPU
Detachable with 2 foot coiled cord
95 keys in standard QWERTY format
13 Key Numeric pad
Independent Caps Lock and Shift Lock
55 Software programmable function keys
All keys auto-repeat after 1 second delay
All Standard cursor and terminal control keys

Disk System

Controller:	WD1793
Drives:	5.25 Double Sided, Double Density, 400K 48 TPI

Built-in disk interchange formats: Xerox 820 (SD, DD), Kaycomp (DD), DEC VT-180 (SD), Osborne (SD) and IBM-PC (eg. CPM/86) and Televideo 802 (Read/Write and Format compatibility) (Expandable to 61 Formats)

Specifications
General Mechanical and Electrical

Width	-17.5 inches (44.45 cm)
Height	- 9.0 inches (22.86 cm)
Depth	-16.0 inches (40.64 cm)
Weight	-24.6 pounds (11.1 Kg)
Power	-80-130 VAC or 190-245 VAC 50/60 Hz 170 watts max

Display

Display Tube:
9'' diagonal, Green or Amber
High resolution display circuitry
60 Hz refresh rate

Display Format:
25 lines x 80 columns
5x7 Character Font with full descenders
128 ASCII Characters
8x9 32 Characters Graphic Font
2K Memory Mapped Display Buffer

CPU Board

Z80A CPU running at 4 Mhz with no wait states
64K bytes of 200 ns RAM (58K after CP/M loaded)
16K bytes of EPROM (2732) can be switched in and out by software
12K available for user EPROMS
8275 CRT controller, DMA driven
1793 Floppy disk controller, SMC data separator
Bipolar proms configure 10 addresses
Fully structured interrupts prioritized by bipolar proms

Interfaces

- Full asynchronous RS232 port with modem control. Baud rates and data translation and protocol programmable
- Full asynchronous full duplex RS232 port with hardware handshake (for printers). Baud rates and protocol programmable. (Serial Printer Port)
- One 8 Bit parallel port with independent strobe and ready lines. Supports Centronics interface with an available adaptor cable.
- IEEE 488 Bus Master Port (ie: General Purpose Instrumentation Bus) not Software Supported.
- 21 Standard Software Programmable Baud Rates: 45.5 to 19,200 BPS

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CIRCLE 261 ON FREE INFORMATION CARD

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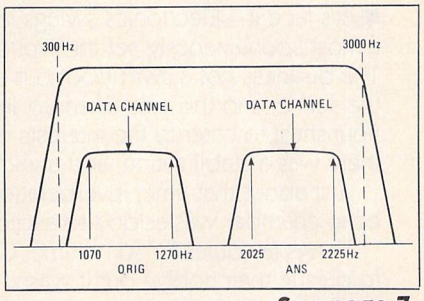

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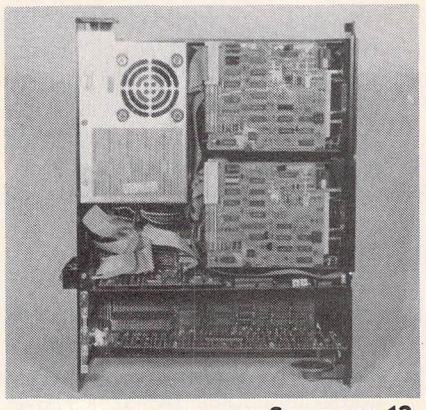

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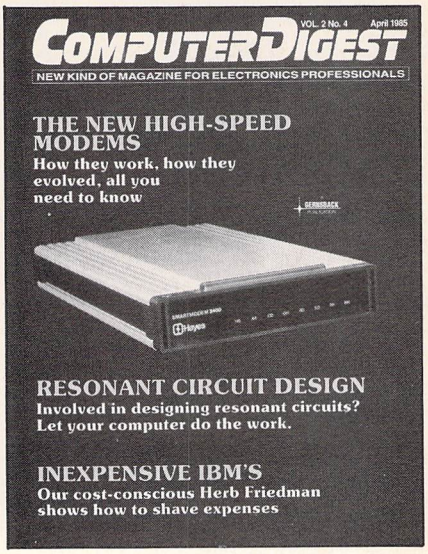
ON THE COVER

The 2400 BPS Smartmodem transfers data across regular telephone lines and offers a link between mainframe and personal computers. The unit has expanded capabilities to monitor the progress of a call, distinguishing between a busy signal, no dial tone or no answer. For additional information on modems, see page 7.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EDITORIAL

Computers and the CB Syndrome.

■Let's face it—Electronics swings in wide patterns of interest that flare up almost spontaneously, set the world afire, and then ignominiously die out. The business got a swift boot out of high fidelity when that first burst on the scene, and this was taken up, in turn, by stereo. Audio-type magazines flourished to cater to the interests of those who followed these trends. Then there was a stabilization, and a wide-spread moderating.

Just about that time, reverberation came into being, and the artificial echo chamber was added to audio systems. Audio came back to life.

Things lay quiet for some time. Oh, the die-hards and purists continued to pursue their hobby, but it wasn't quite like the "good old days." Then Citizens Band Radio came along, and it was bigger than audio ever was. Everybody got involved. Every car had a CB rig. Housewives were forming networks to gossip over the air. Teenagers were making dates over the CB. And CB, once the realm of truckers alone, was now everybody's property. You could hear the bands bristling with phony southern accents as the kids tried to emulate the truckers. The language the CB'ers developed was as unique as some of their "handles." And of course, magazines catering to the new interest flourished as well.

Then, as suddenly as it appeared, the interest in CB died off. People who once craved an occasional "Good buddy, how's it look over your shoulder," as they drove down the road, were just as happy listening to the BC radio. Now when you see a car ahead of you on the road, you begin by asking "Hey good buddy, got your ears up?"

Now it's computers, and again, everybody from school kids that have just learned how to read, on through graduate engineers, are taking up the computer cudgle. Magazines have sprung up and died out. Is the computer to face a like fate as all its forebears?

No. The computer, thanks to its innate value, will never exhaust the interest that holds its practicioners spellbound. Because of its extreme versatility, the computer is going to be with us for many, many years to come, and we at **ComputerDigest** hope to continue to bring you the latest news and developments in this astounding field.◀CD▶

Byron G. Wels

Byron G. Wels
Editor

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LETTERS

LIKES "PRINTER PROBLEMS"

I found the "Printer Problems" articles in **ComputerDigest** to be *very* useful. How about more hardware and interconnect related articles?—Warren W. Munro, Aiea, HI.

Right, Warren. We've got lots of those in the works right now. Keep watching for them; they'll be appearing regularly.

A ROBOT NAMED "BYRON?"

I named my robot Byron immediately after soldering in the last connection and powering him up. This in recognition of a kindred spirit. Hope you don't mind. Byron isn't finished yet as he has a total lack of mobility. At least he knows who his maker is! WORKING!!!—T. E. Deagle, Boydton, VA

We all had a good laugh here in the office over that one, T. E. The general impression is that you did well. I don't have too much in the way of mobility either, but at least your Byron works!

BUILD YOUR OWN COMPUTER?

I have good skills, have been an electronics hobbyist all my life, and was wondering about the idea of building my own computer from scratch. Would I save money on this? How would I best go about it? By the way, I don't want to build from a kit, either.—J. Mahoney, Sioux Falls, S.D.

We can't really recommend this course of action. While it could be done, it would not be economically feasible, compared with buying a used or refurbished unit. Do let us know what you decide, and share what you learn with our readers. We'll all be very interested!

UNUSUAL REQUEST!

I know a lot of people have been buying **Radio-Electronics** and ripping out and throwing away **ComputerDigest**. You may not believe this, but I buy the magazine, rip out **Computer-Digest** and throw **Radio-Electronics** away! I hate to see it go to waste each month, and was wondering if one of your non-readers might like to split the cost with me for a subscription?—S. Brandt, Caspar, WY

Any takers?

PROTECTING INVENTIONS

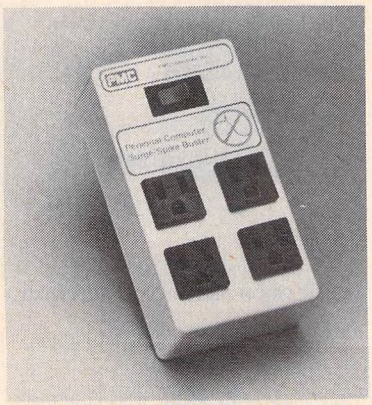
I've invented a computer-oriented device I'd like to protect, but can't afford a patent. Any suggestions?—Sam Dixon, San Francisco, CA

There are several "ideas." If it's sufficiently interesting, get it published in a magazine like **ComputerDigest**. *The magazine and its contents are copyrighted, and it gives you proof of prior published art. Another old saw is to write up a description and mail it to yourself in a sealed, registered letter to later be able to prove earlier discovery. The smart money suggests investing in a good patent attorney and playing it really safe!*◀CD▶

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

SURGE/SPIKE SUPPRESSOR, model *061,* is designed to protect computers, microprocessor-based instruments,



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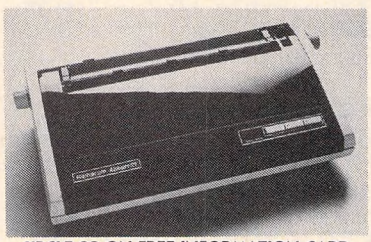
sensitive electronic and audio equipment, and scientific instrumentation from high-voltage transients and surges by instantaneously sensing and suppressing them.

The model *061* features suppression capabilities of 6,000 amperes maximum surge current, with an energy absorption of 70 joules. It is designed for use on any standard 120-volt AC line, and responds to common and differential mode transients and surges at once. There are 4 three-wire grounded outlets and a main ON/OFF lighted rocker; the unit plugs directly into any 3-prong grounded outlet to provide maximum convenience. It is priced at $59.95.—**PMC Industries, Inc.,** 9353 Activity Road, San Diego, CA 92126.

DAISY-WHEEL PRINTER,

The *Alphapro 101,* is a 20 character-per-second printer that uses standard Diablo and Qume-compatible print wheels and ribbon cartridges. It uses an intelligent printer cartridge to adapt



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it to all popular personal computers, including those with Centronics

ports—such as the *IBM, PC, PCjr,* and compatibles; those with RS232 ports, such as the *Apple IIe* and the *IIc,* and others, such as Apple's *Macintosh.*

The *Alphapro 101* features path-seeking logic to maximize printing speed and a 93-byte memory buffer (4000 bytes optional). True proportional spacing, boldface, double strike, strikeout, phantom face, superscripts and subscripts, and reverse line feeds are also supported. It is priced at $399.95.—**Alphacom, Inc.,** 2323 Bascom Ave., Campbell, CA 95008.

EDUCATIONAL PROGRAM, *Bumblebee,* is designed to introduce children age 6 and up to the disciplines of computer programming in a game-like format.

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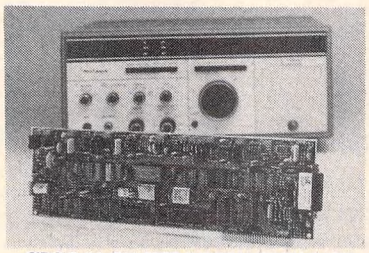
The player controls Bartholomew ("Bart") the bee by giving him instructions that enable him to move from flower-to-flower and pick up "pollen points." The bee's flight must be carefully designed, or he will bump into walls or be caught by "Olga," the evil garden spider. If Bart returns safely to the beehive, the screen lights up in a colorful graphic display.

Bumblebee features increasing levels of difficulty, some of them requiring the construction of more complicated flight patterns. The disk-based program is priced at $29.95.—**Creative Software,** 230 East Caribbean Drive, Sunnyvale, CA 94089.

RADIO INTERFACE CARD, model *PCI-2000,* is a plug-in card for the IBM-PC, which interfaces the computer to a shortwave radio for copying radio-teleprinter and Morse-code signals. Examples of signals that could be copied include weather information, news services, and amateur radio communications. The model *PCI-2000* can also transmit Morse and teleprinter



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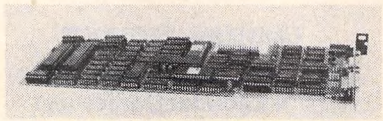
signals in applications where two-way radio communications are required. It is priced at $595.00, including software.—**HAL Communications Corp.,** Box 365, Urbana, IL 61801.

CO-PROCESSOR BOARD, for the IBM, PC and XT, the *Trackstar,* supports Apple DOS 3.3, Pro-DOS, Apple Pascal and Apple CP/M 2.2. With the addition of the *Trackstar,* the IBM user can access the vast library of Apple games, educational and business programs, and the extensive library of CP/M business software.



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Additional features include a full 80-column mode, connector for an Apple-compatible disk drive to overcome copy-protection problems, both RGB and composite output and support of the language card features. *Trackstar* is priced at $695.00.—**Diamond Computer Systems, Inc.,** 3380 Montgomery Drive, Santa Clara, CA 95054.

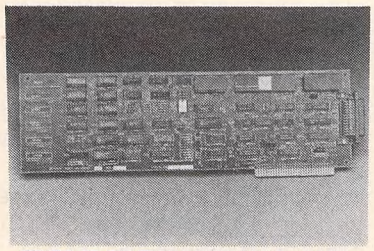
TRAINING PROGRAM, *The Desk Organizer,* is for use with the IBM PC, and designed for training secretaries. *The Desk Organizer files* anything the user needs to remember, for instant recall at any time; *dials* phone calls, retrieves phone numbers, inserts access codes; *writes* and prints memos, letters, reports; *calculates* with a visual

CIRCLE 26 ON FREE INFORMATION CARD

calculator and an electronic tape, stores and runs equations and formulas; *transfers data* automatically from mode to mode; *organizes,* alphabetizes, indexes, cross-references, and *manages time* with chimes to remind the user of commitments.

The Desk Organizer is priced at $195.00.—**Warner Software,** 666 Fifth Avenue, New York, NY 10103.

DATA COMMUNICATIONS BOARD, the model *WD4025,* features the universal CCITT X.25 LAPB protocol, and is designed to be compatible with the IBM PC, XT, AT, and compatibles. It will link computers at the same site, or scattered across the country via dial-up, or leased lines through a packet



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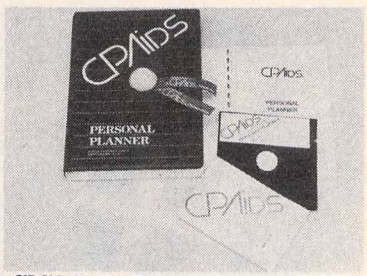
switching network. It will also provide a gateway connection for the Local Area Networks (LAN).

Pricing for the model *WD4025* without software in OEM quantity is $385.00; pricing with software is $695.00.—**Western Digital Corporation,** 2445 McCabe Way, Irvine, CA 92714.

TAX SOFTWARE, the *Personal Planner,* can calculate tax liabilities for 1984 through 1987. It organizes all relevant tax information, keeping everything available for instant evaluation. It can be used for such tasks as retirement planning, investing, IRA contributions, home buying, two-income planning, and even checking a federal tax return.



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The *Personal Planner* carries a suggested retail price of $49, and is tax-deductible.—**CPAids,** 1061 Fratermity Circle, Kent, OH 44240.

MODEMS

All about the newest high-speed modems; where they are and how they work.

MARC STERN

■For those who maintain that the higher the baud (communications) rate the more bandwidth is needed, 9600-baud communications may seem like an impossibility over the standard phone system, which is limited to 3 KHz of bandwidth, or the range of average voice conversation. After all, 9600-baud is a 3200 percent increase over 300-baud. But, modem manufacturers have done it.

Frequency Shift Keying

As recently as three years ago, the state of the art in digital communications was 300-baud. The typical 300-baud 103A modem of 1981 used two pairs of arbitrary frequencies for send and receive (originate and answer), 1070 to 1270 Hz for originate and 2025 to 2225 Hz for answer. (See Fig. 1) These are the tones emitted by both modems during a call. You can hear them if you listen closely during dial-up. The 300-baud modem also used Frequency Shift Keying (FSK) to represent the digital data being transmitted. (The 103A standard defined the originate-answer tones needed for data transmission, as well as the parameters needed for communication. All modems which adhered to this standard could communicate, one in the originate mode and the other in the answer mode.)

Fig. 2 shows a graphic representation of FSK. In this type of data transmission, the modem's circuitry modulates the carrier frequency to one level to represent a digital 0 and to another to represent a digital 1. You can actually hear the data stream of 1s and 0s if you listen to the phone line during a low-speed (300-baud) transmission. This type of transmission relies on a UART (Universal Asynchronous Receiver/Transmitter) as well as the circuitry which takes the digital signals from the UART and transforms them into audio signals which are compatible with the phone system.

The reason digital data must be turned into audio is that the phone system is geared toward voice audio with its bandwidth of 3 KHz. Since it is, data must be turned into its audio analogs and FSK is used to produce those analogs.

Let's see what happens when you begin digital communications at 300-baud (300-bits-per-second). First, your computer establishes a connection with the remote computer system or terminal with which you want to communicate. With today's intelligent modems, you just call up a program in your computer and command it to dial the remote system. After the dialing and the call are completed, you will hear a tone emanate from your modem. It is the originate carrier and is transmitted for a length of time as your modem patiently waits for the answer tone. When it hears the answer tone, the modem latches onto it and your system is connected to the remote system. These tones are generated by the modulator section of the modem.

Now the communications program in your computer waits for your action. If you are the originator of the call, the chances are good you will either be uploading or downloading information. Let's say you are sending—UPloading— a file to the remote system. If you are, you will be asked for the filename which you select. You then hit the appropriate keys on the keyboard and the transmission begins. While you were choosing the file, unknown to you, the program was putting the modem's UART into a *ready* state.

(A computer works in a parallel mode within the confines of its box with all data moving along in 8-bit chunks, unless you have a 16-bit computer and then it moves along in 16-bit or 24-bit chunks.)

With the UART ready, the file transfer session begins. The UART takes the parallel data and turns it into serial data, holding each piece of data in place until it is ready to be sent by the transmitter section of the modem. The UART has the necessary storage registers to do this.

At this point, the UART begins releasing the data to the transmitter section, where the data are changed from their digital forms into their audio analogs and it is then frequency modulated through the phone system.

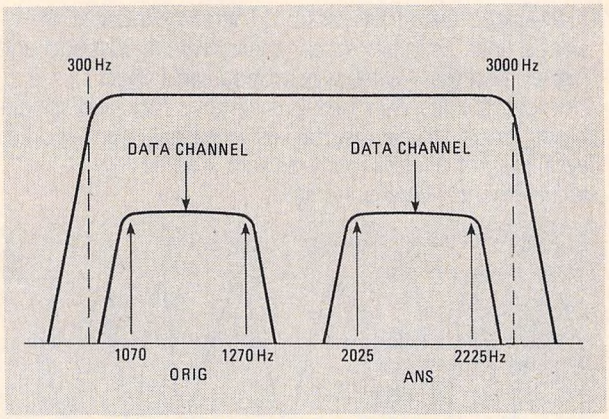

FIG.1—THE 300-BAUD ORIGINATE/ANSWER modem uses two sets of discrete frequencies to establish communications. When the modem originates a call, the tone is between 1070 and 1270 KHz. The answering modem emits a tone in the 2025 to 2225 KHz range. The top and bottom frequencies correspond to mark and space, two timing parameters used in asynchronous communication.

Receiving

Let's see what happens when audio information is received.

On the receiving side, the modem takes the audio information it is receiving and turns it back into digital form. The receiving circuitry sends this information to its own UART, where each bit of information is held in storage until the particular digital word is formed. When that 8-bit word is formed, it is sent to the computer's information bus and on into digital storage. The action of the UART and its associated circuitry is so fast that you think everything is happening instantly, but it isn't. If you could slow this circuitry's time reference enough you would see that each digital event is distinct in itself. However, the speed with which each event occurs is so high —microseconds—that it appears instantaneous.

In the 1981-1982 period, data transmission was limited to the 300-baud rate because the circuitry for higher-speed transmission still hadn't migrated to the average microcomputer user. It was beginning to make its appearance, but was still too expensive for the average computerist. It took developments in large-scale integration (LSI) to make this possible. These developments included UARTs which could handle data at 1200-baud asynchronously, as well as microcircuitry which could create the proper modulation needed so the modem would recognize high-speed transmission.

Asynchronous transmission

Asynchronous simply means data transmission without tight timing Constraints and it is important to note it here. At this time, the highest speed thought possible for asynchronous communication was 300-baud (300 bits per second). At higher speeds, it was thought that tight timing requirements were needed so both the transmitting and receiving modems could operate reliably. It was also believed that you needed a specially dedicated, conditioned—clean—phone line so that data transmission would be error-free. It was assumed the phone system was too noisy for reliable high-speed data transmission. Therefore those high-speed links which existed—there were 1200-baud and higher systems—were synchronous and used dedicated lines. Synchronous systems required special timing codes to be inserted as "header" information for each packet of data that was sent. The timing requirements were quite strict.

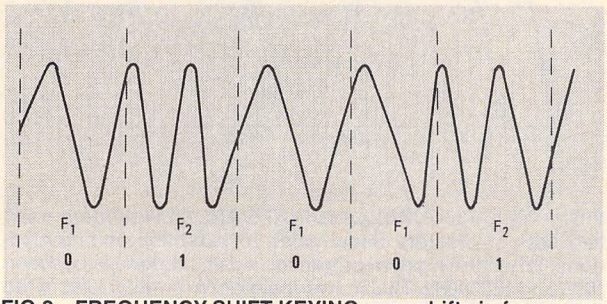

FIG.2—FREQUENCY-SHIFT KEYING uses shifts in frequency to denote digital information. One frequency level denotes digital 0 and the second denotes digital 1.

Phase Shift keying

Phase Shift Keying (PSK) takes advantage of the natural period of an audio frequency wave and, rather than using a set of discrete frequencies to define digital 1s and 0s, PSK represents data bits by using the changing phase of the signal and superimposing two or more data bits for each cycle.

Visualize a sine wave

The best way to envision this is to think of a sine wave, showing the entire period of an audio signal. Now, put a dot at the 0 point and another at the 180-degree point. These two points represent the digital 1 and 0, or the binary system used in data communications. This system iscalled Coherent Phase Shift Keying and relies on defined reference points to represent data. It differs from FSK in that FSK relies on using the carrier frequency to represent one digital bit of information—0, for instance—and a higher frequency to which it shifts to represent the other—1, for example.

To explain this more fully, let's say you are using traditional FSK to transmit data. Since you are using an audio-frequency range, you are also creating sidebands, or the sum and difference of the carrier and the modulation rate. For example, let's say the modem uses an 1800 Hz carrier and you are sending data at 1200-baud. Because the modem is using this set of parameters, you will find sidebands at 3000 Hz—1200 + 800—and 600 Hz—1800-1200—and therefore higher-speed transmission can fit within the constraints imposed by the phone system.

With low-speed (300-baud) and FSK, you are simply using one-half the cycle to define the data you are transmitting. This is the key difference between modes. FSK uses the 1800 Hz point, for example, to define 0 and the 2100 Hz point or upper sideband (1800 + 300) to define 1. The lower sideband or 1500 Hz point is unused. Further, this type of modulation does not take full advantage of the 3000 Hz bandwidth of the phone system, while higher speed and PSK do. Low speed and FSK only uses about 600 Hz of bandwidth—2100-1500 Hz—leaving 2400 Hz unused.

Another way to go

Coherent Phase Shift Keying isn't the only way of handling high-speed data communications. There are two others which are equally as valid and interesting, Amplitude Modulation (AM) and Differentially Coherent

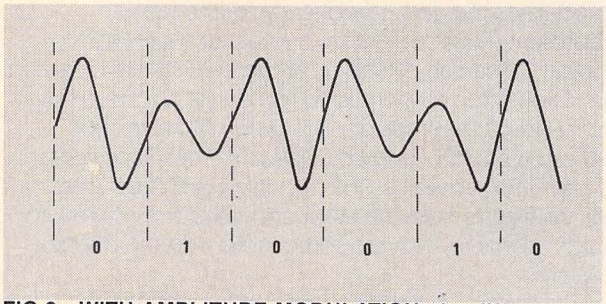

FIG.3—WITH AMPLITUDE MODULATION, the difference in amplitude of the modulating signal determines the digital information flow.

Phase Shift Keying (DCPSK).

With Amplitude Modulation, the amplitude of the carrier is the determining factor. By varying the amplitude of the carrier, with one level representing a digital 1 and another representing a 0, you can have effective data communication.

To represent this, think of the traditional AM sine wave and then superimpose a modulating signal upon it. The difference in amplitude of the modulating signal determines the 1 and 0. (See Fig. 3).

Another form of Amplitude Modulation, is simple on-off keying where the digital 1 or 0 is determined simply by switching the carrier on and off. While we

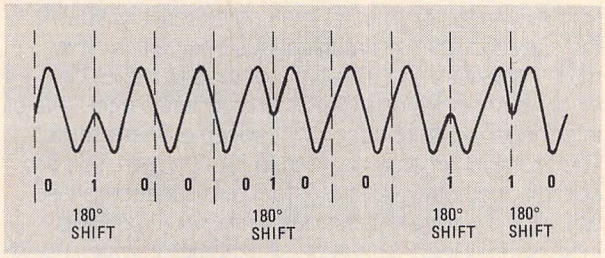

FIG.4—HIGH-SPEED MODEMS, which use phase-shift keying, use changing phase relationships to attain their speed while remaining within the constraints of the phone system. Figure 4 demonstrates this using a 180-degree phase shift.

call this Amplitude Modulation, it's really Interrupted Continuous Wave (ICW).

DCPSK

With this said, let's move on to Differentially Coherent Phase Shift Keying (DCPSK). It is unlike Coherent Phase Shift Keying in that the necessity of identifying specific locations on the sine wave is discarded in favor of encoding data using the phase change between two signal elements.

And because there's an almost unlimited potential for encoding data during phase changes (See Fig. 4), you can see it would be possible to increase data transmission speed without increasing bandwidth. Large-scale integrated circuitry handles the necessary detection and decoding of data.

How DCPSK works

Let's take a closer look at DCPSK for a better understanding of this concept by first comparing it to coherent PSK. As we have noted, coherent PSK relies on establishing reference points on the sine wave's cycle. For instance, this type of modulation technique may use the 0 and 180 degree points, with a 0 degree phase shift representing the digital 0 and a 180 degree shift representing the 1. The circuitry in the receiver requires phase coherence capability so it can demodulate the signal. DCPSK, on the other hand, does away with the necessity of absolutely identifying the reference points in the shift of an audio wave cycle. Instead, data are encoded in terms of the phase change between successive parts of the audio wave.

To see this more clearly, envision the coherent PSK

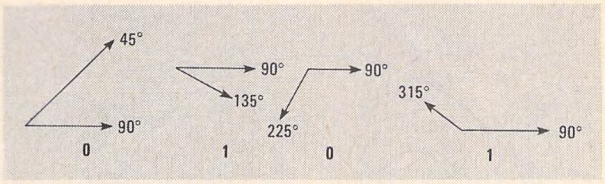

FIG.5—DEMONSTRATING THAT ENCODED BITS OF DATA—two bits—using a phase shift relationship of 45 degrees is one of many possibilities. Here data are encoded at 45, 135, 225, and 315 degrees on the signal cycle. Each is still separated by 90 degrees.

waveform with data points at 0 and 180, or the type of waveform you might see if you scoped a 1200-baud modem. Change the waveform slightly to encode data at different spots on the wave. The difference in phase between these insertion points is what defines the digital 1s and 0s needed for data communication. For instance, with DCPSK, you may have data inserted at 0 degrees, 90 degrees, 180 degrees and 270 degrees, or a two-fold increase in communication speed since two full digital bits are represented on the wave. This is called a dibit, with 0 and 180 representing one set of 1s and 0s and 90 and 270 representing the second set. We only used these points for easy reference because there is no hard and fast rule defining where the information is to be inserted. It can be anywhere on the waveform. (See Fig. 5)

On the receiving side, the DCPSK discards the necessity for fixed reference points, relying, instead, on the relationship between the changing phase between the signal elements.

By now you should be able to see the possibilities inherent with DCPSK. By using the change in phase, you can take advantage of as many as four, eight or 16 phases on the signal and this, in turn, allows you to group two, three and four bit groups of data. It gives you a fourfold increase in the amount of data transmitted within the constraints imposed by the phone system. You are taking full advantage of the bandwidth available and all the while the phone system still thinks you are using a 1200-baud modem because you are still relying on the same bandwidth we noted in our earlier example (600 and 3000 Hz or the sum and difference of the 1800 carrier and 1200 Hz modulating signal.)

Since this type of communication relies on timing shifts, it requires synchronous operation. It is also uses multilevel data coding in the modem. Research has found a relationship between the amount of data you send per signaling period, also called the bandwidth compression ratio. It is log 2 M, where M is the number of levels (signal elements per cycle). This type of coding can be applied to any form of modulation.

The one drawback with DCPSK is that as you increase the amount of digital data within a waveform, you need a higher signal-to-noise ratio in the receiver. This is usually handled by either increasing the power of the transmitter or lowering noise levels.

Introducing Quadrature AM

It is possible to combine Amplitude Modulation with DCPSK. Also known as Quadrature Amplitude

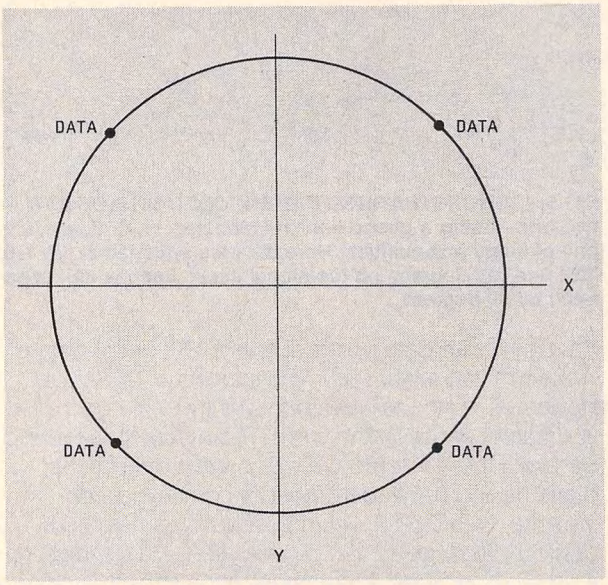

FIG.6—TO SIMPLIFY MATTERS, the relationship of data in a 2400-bit modem is shown as it would appear on an oscilloscope. Note the relationship of the four insertions of data.

Modulation, it can use a two-level AM, four-phase scheme to encode three data bits and achieve high-speed communications. It is also possible to use a two-level AM, eight-phase scheme to encode four bits of data per cycle. You can see where the name quadrature came from since it relies on the four-phase relationship.

At 1200-baud, the standard 212A modem takes advantage of coherent PSK for its high-speed, 1200-baud mode and uses FSK for 300-baud. (Bell standard 212A, which defines the characteristics for 1200-baud asynchronous communication. All 212A modems share the same standards so they can talk with one another. This standard supercedes the older Bell 202 standard.)

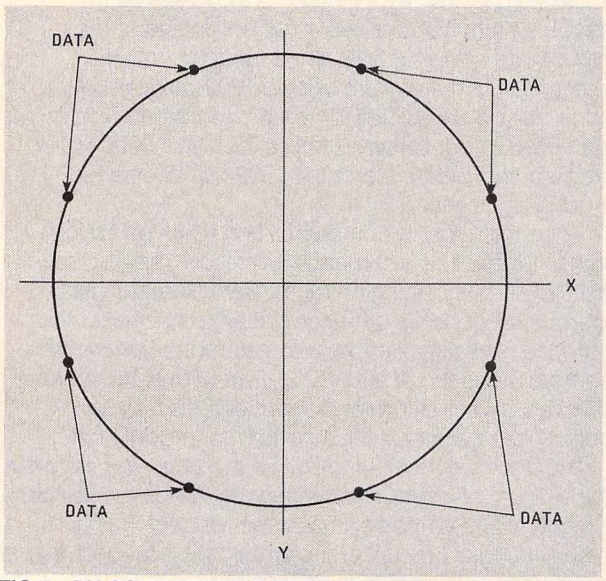

FIG.7—BY COMPRESSING THE DATA, another bit can be inserted, effectively doubling the modem's speed to 4800-baud. By compressing the data, another bit can be inserted, effectively doubling the modem's speed to 4800-baud. The relationship, as it would appear on an oscilloscope, is shown above.

This type of modem is capable of recognizing both FSK and PSK.

Dibits and Tribits

The jump from 1200 to 2400 is achieved by using a dibit—two bits of data. The dibit—00, 01, 11, 10, for instance—is used to encode one of four specific phase shifts. For instance, a 2400-baud modem will function using four-level DCPSK modulation with a phase change of 45 degrees between bits. Pictorially, it can be seen in Fig. 6. Since there are now four bits of information, rather than two, the amount of information is effectively doubled, though the phone system thinks the modem is communicating at 1200-baud.

Inserting another data bit and increasing the number to three—a tribit—means you can effectively double the speed of the communications once again. This makes it 4800-baud. This type of modem relies on eight-level or diagonal DCPSK and requires three bits of information to define the eight specific phase shifts. The tribit pattern can be seen in Fig. 7. Again, you are adding one extra piece of information at each phase shift point—compressing data—allows a manifold increase in speed. This type of scheme operates using eight data patterns which look much like triangles when superimposed on one another. Although it would seem

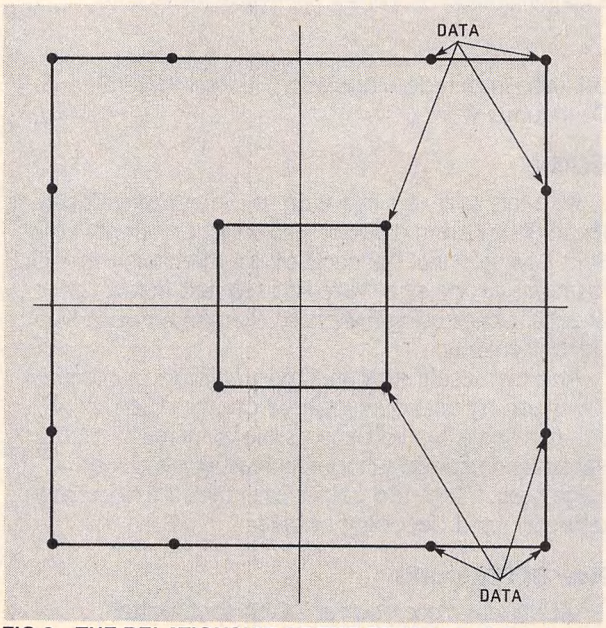

FIG.8—THE RELATIONSHIP OF THE FOUR bits of data inserted at various points on a signal cycle in a 9600-baud modem is shown. These points not only determine the phase relationship, but also the relative amplitude of the signal.

that you would only be increasing speed to 3600 baud, you now have eight levels of data and six bits of information per cycle, $8 \times 6 = 48$.

Moving from this point, speed again doubles to 9600-baud. This type of modem uses Quadrature Amplitude Modulation and uses four consecutive data bits to define both the amplitude of the signal and phase changes. It also determines the absolute phase of the signal element. You can see the relationship of all the elements in this realm in Fig. 8. ◀Ω▶

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- Posts summary transactions to the General Ledger
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- Prints sales or dunning messages on statements
- Handles ten different types of transactions
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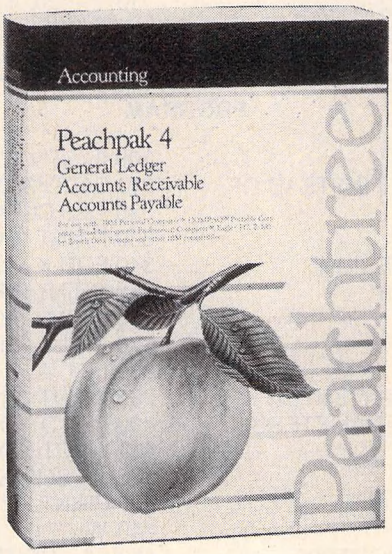

Accounts Receivable provides these reports: Aged Receivables Report, Customer Statement, Invoices, Transactions Report, Examine Customer Activity Report, Customer Accounting Listing, General Ledger Transaction Register, and several control reports.

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- Has an option to prohibit deletion of invoices
- Allows year-to-date total up to $21,000,000.00

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RESONANT CIRCUIT DESIGN

If you're designing resonant circuits, try putting your computer to work!

LAWRENCE G. FRIEDMAN

■"Resonant Circuit Design" is a generic BASIC program specifically intended for technicians and experimenters who work with RF circuits or RF filters. "Resonant Circuit Design" will calculate the F, C and L (Frequency, Capacitance, and Inductance) values for a resonant circuit and then go on to calculate the design of an air-wound coil using the calculated or a preselected inductance value.

The program automatically recycles: If the calculated inductor and capacitor values aren't to your liking, you can substitute different known values over and over until you get practical answers.

Finally, you select the coil's dimensions and the program will calculate the required number of turns and the maximum size solid enamel-insulated wire that can be used to wind the coil. This part of the program also recycles, so if you don't like the answer(s) you can specify other dimensions and the computer will automatically recalculate the number of turns and the maximum size wire.

If you want to use a specific size wire you can recycle the parameter section and vary the dimensions of the coil until the desired wire size is indicated.

The program listing is for clarity and universality rather than memory conservation or "pretty printing." In some instances I have taken the "long way 'round" to insure the program will run on most, if not all, modern personal computers—including the pocket-sized portable models.

Possible "translation" problems are indicated in lines 10 and 20. If your computer uses different commands or symbols for CLEAR SCREEN and exponentiation, make the required changes to the program.

To keep the program reasonably short error-trapping is used only for line 110 where there is the possibility of an incorrect keyboard entry. Other than the keyboard entries ahead of line 140, if you deliberately try to trick the computer with false entries or data the computer will respond with a false answer. But give the program the data it asks for and it will crank out correct values as fast as you can handle them.◀CD▶

PROGRAM

```
 10 REM. CLS="CLEAR SCREEN"
 20 REM. SOME COMPUTERS USE [ INSTEAD OF
    ^ FOR EXPONENTIATION
 30 CLS
 40 PRINT "RESONANT CIRCUIT DESIGN"
 50 PRINT "By Lawrence G. Friedman"
 60 FOR X=1 TO 500:NEXT X
 70 CLS
 80 PRINT TAB(10) "MENU":PRINT
 90 PRINT "TO DETERMINE L, C, OR F ENTER 1"
100 PRINT "TO CALCULATE COIL PARAMETERS
    ENTER 2
110 INPUT A
120 IF A=1 GOTO 160
130 IF A=2 GOTO 320
140 CLS;PRINT "RE-ENTER":PRINT:GOTO90
150 IF A=2 GOTO 320
160 CLS:CLEAR
170 INPUT "ALSO CALCULATE COIL PARAMETERS
    (Y/N?)";A$
180 CLS
190 PRINT "ENTER A'0' FOR UNKNOWN VALUE"
200 PRINT
210 INPUT "ENTER F IN MHZ>";F
220 INPUT "ENTER L IN UH> ,;L
230 INPUT "ENTER C IN PF>";C
240 IF F=0 THEN PRINT 1000/(6.238 *
    SQR(L*C));"MHZ"
250 IF L=0 THEN Z=25330/((F^2)*C)
260 IF L<>0 THEN Z=L
270 IF L=0 THEN PRINT 25330/((F^2)*C);"UH"
280 IF C=0 THEN PRINT 25330/((F^2)*L);"PF"
290 IF A$="N" THEN 200
300 IF A$="n" GOTO 200
310 GOTO 390
320 CLS:CLEAR
330 PRINT "COIL PARAMETERS"
340 FOR X=1 TO 1000:NEXT X
350 PRINT:PRINT
360 IF Z<>0 GOTO 390
370 INPUT "ENTER L IN UH>";L
380 LET Z=L
390 INPUT "ENTER COIL DIAM. IN INCHES";D
400 LET D=D/2
410 INPUT "ENTER COIL LENGTH IN INCHES>";G
420 T=SQR((Z*((9*D)+(10*G)))/D)
430 PRINT T;"TURNS"
440 W=T/G
450 C$="IS THE LARGEST WIRE SIZE."
460 IF W< 18.9 THEN PRINT "#16";C$:GOTO 540
470 IF W< 23.6 THEN PRINT "#18";C$:GOTO 540
480 IF W< 29.4 THEN PRINT "#20";C$:GOTO 540
490 IF W< 37 THEN PRINT "#22";C$:GOTO540
500 IF W< 46.3 THEN PRINT "#24";C$:GOTO 540
510 IF W< 50 THEN PRINT "#26";C$:GOTO 540
520 IF W< 72.7 THEN PRINT "#28";C$:GOTO 570
530 IF W< 80.5 THEN PRINT "#30";C$: GOTO 540
540 PRINT:INPUT 'REPEAT PARAMETER DESIGN
    (Y/N?)";R$
550 IF R$="Y" GOTO 390
560 IF R$="y" GOTO 390
570 INPUT "REPEAT L,C,F CALCULATION
    (Y/N?)";P$
580 IF P$="Y" GOTO 160
590 IF P$="y" GOTO 160
600 END
```

INEXPENSIVE IBM'S

Third-party hardware can mean big savings and added performance for your IBM PC.

HERB FRIEDMAN

■While calling the IBM PC a home-and-family computer stretches the limits of the imagination (because of its price, for one thing), it is true that for business use—even for a kitchen-table operation—the IBM PC is the way to go. Why? Because most high-performance software is written first for the IBM *PC*. This makes the PC a very attractive machine in the eyes of many. And if you require some highly-specialized software, chances are that you'll find it ready and waiting if you have a PC to run it.

Unfortunately, an IBM *PC* is expensive, and gets more so as you add accessories. In fact, you cannot even use an IBM *PC* until you have spent several hundred, or even a thousand dollars for peripherals and accessories. Essentially, the *PC* works on the same principle as the Barbie Doll: the basic doll is relatively inexpensive or affordable; it's Barbie's clothes and accessories, not to forget the boyfriend Ken doll and his accessories, that eat up the budget. (Barbie and Ken dress better than I do!)

But there are ways you can save anywhere from $300 to over $1000:

- Plan carefully so you don't duplicate features.
- Be patient and shop around.
- Have a moderate (at least!) understanding of what you need and what you can substitute for.
- Assemble your own IBM *PC* system, substituting third-party components—hardware not manufactured by IBM—wherever it won't affect, or will actually improve overall performance.

Besides saving money, you'll end up with a *PC* having many more features than IBM offers and a model that's customized for your particular needs. The minimum IBM *PC* configuration that can be purchased (at the time this article was prepared) has 64K RAM and one double-sided disk drive. It retails for $1815. But for real computing power you'll need a second disk drive ($425, IBM's price). And if you intend to run a printer you'll need at least one printer adapter, which costs $75 (parallel) or $100 (serial). Something missing? Right! There's no video output or monitor. An IBM color/graphics adapter, which has a composite output suitable for color or monochrome, will cost $245, and the least expensive "recommended for IBM"monochrome monitor will cost about $150. So for a computer with two drives, a video monitor and a printer output you would have spent at least $2710, only to discover that few programs run in 64K RAM: you'll often need at least 128K, preferably 256K. IBM charges $100 for each 64K of RAM, so your total bill will be $3010, and you won't even have a serial output for a modem, or a printer. Now if you have read the advertisements in the big city newspapers and the mail order catalogs, you have probably discovered you can purchase a "standard" *PC* system for well under IBM's price, often saving in the area of $300 to $700 depending on the specific hardware you select—or what the dealer insists you *must* purchase.

Is this a discount on the IBM computer? Usually not. In many instances the dealer is using an IBM "bare system," which comes with only 64K of RAM, a keyboard and nothing else. He fleshes the system out using third-party hardware and peripherals. Third-party hardware is the stuff that isn't sold by IBM. For example, IBM charges $425 for a single disk drive with the IBM logo etched on the front panel. You can purchase a Tandon 100-2 or CDC-9409 disk drive without the IBM logo for about $200, a savings of approximately $225 per drive. Let's look at another example. IBM gets $100 per 64K RAM. The Great Salt Lake Computer Company (1780 West 2300 South, Salt Lake City, UT 84119) sells the 64K kits for about $50, or $150 for three kits, a savings of $150 when expandng the system from 64K to 256K. As you can see, this isn't one of those articles on how to save pennies: we're talking about a lot of money, often the difference between whether you, your business, or your school can afford an IBM *PC*; and we haven't even started discussing extra features yet.

The basics

First things first, you must get a bare system, officially called "System Unit 64K," whose part number 5150104 is often shortened to simply "...104." This isn't the easiest of things to locate. At the time this article was prepared it was no longer on the price list of some IBM

product centers, and neither the local Computerland nor Sears Business Systems would sell one to an individual. (They don't want to sell you one because they don't want you building up a complete computer system for less money than they will charge you.) However, business is business, and advertisements offering a "bare PC"are appearing with increasing frequency.) Even some IBM product centers suggest they will be selling them in early 1985 when the anticipated demand for the IBM *PC* slackens.

If you are offered a bare PC at any price—list or discounted—take extreme care to be certain you are getting a PC2—the latest version—which is socketed for 256K RAM in 64K modules, each module consisting of nine (yes, 9) ICs (only 64K is provided in the bare unit). The earlier PC, often called the PC1, was socketed for only 64K RAM in 16K modules. Do not accept a PC1. You want a PC2.

Okay, you now have a computer, but there's no display. First thing you'll need is a monochrome monitor. Amber screens are all the rage, but many users find them difficult to use hour after hour. We suggest the monochrome green-screen Zenith ZVM-121, which sells in the discount price range of $90-$115. It has excellent bandwidth, delivers sharp characters from corner to corner, and is the monitor we use when photographing real-time computer video displays. It is in no way the equal of the IBM monochrome display, but it doesn't sell for the IBM's price of $620 (the cost of the IBM monitor plus the required monochrome adapter).

You'll need something that generates an output from the computer for the video display. For that we suggest the $245 IBM Color/Graphics Monitor adaptor, which provides either a 40 or 80 character "composite" (color output also suitable for monochrome), and an RGB color output. Just connect your monochrome monitor to the composite output's phono-type jack. While there are third-party color/graphic monitor boards, they aren't all that much better and they cost about the same as the IBM. And why not go with IBM when the price is about the same? There are other boards that deliver a better graphic display, but they are much more expensive and justified only if you have a need for graphics.

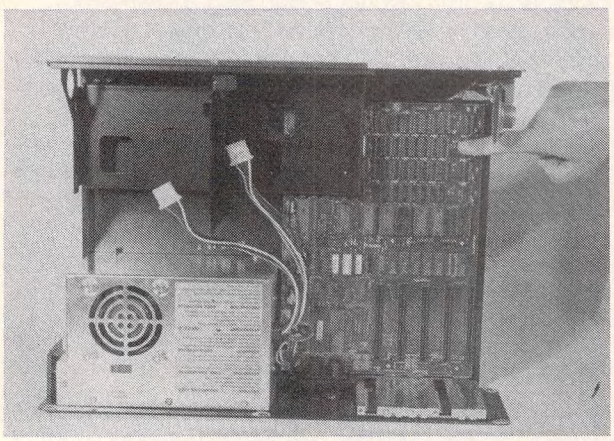

FIG.1—THIS IS THE MINIMUM *PC* system you can get. The finger points to the three rows of empty sockets that the user can populate with low-cost IC's to upgrade the supplied 64K of RAM to 256K.

Disk drives

Next, you'll need disk drives and a disk controller. Many sources sell the Tandon 100-2 and/or CDC-9409 drives for about $200. Find the least expensive source, but if possible—even if it costs a few dollars more—buy them from an outfit that provides installation instructions on how to set the drives' internal jumpers, and which terminating resistor block to remove. If you try to go-it-alone you can spend weeks trying to determine what's wrong, and the IBM service center isn't going to help you with third-party hardware. For this article we obtained the drives from Conroy-Lapoint (12060 Garden Place, Portland, OR 97223), who provides notably good instructions for their disk drives and user-intalled RAM upgrades.

The disk controller

Disk drives need a disk controller to tell them what to do. IBM's own disk controller (called a "disk adapter") now costs only $100—a fantastic value. However, the disk controller takes up one of the five available slots, while the color/graphics monitor adapter takes up another slot: leaving three slots for everything else. If you add a printer and a serial output adapter there's just one slot left for future expansion inside the main cabinet. But the disk controller is a plug-in board, and like other plug-ins such as the parallel and serial adapters, calendar/clocks, and RAM upgrades, they are available from third-party sources.

In fact, greater computer flexibility is attained—though it costs a few dollars more—by using multi-function boards (adapters) from third-party sources. For example, a Maynard disk controller, which can be purchased for as little as $169, is also available with a serial or a parallel printer adapter. Or—and this is preferable—you can use Maynard's *Sandstar* disk interface (approximately $200), which can accept any combination of up to three additional modules: serial or parallel interfaces, a battery-powered clock/calendar, or a game port. The Sandstar interface equipped with a serial and parallel interface is the one we used and recommend. At the minimum, it saves at

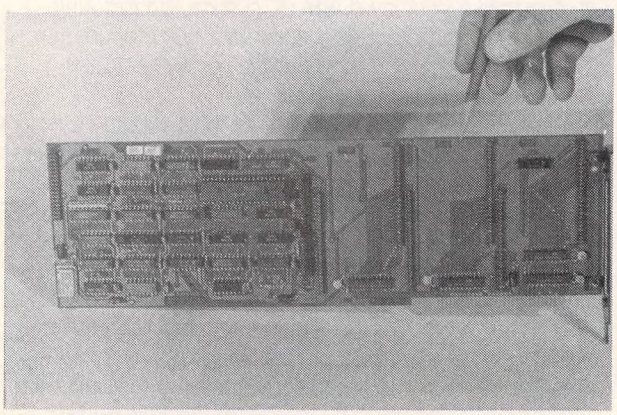

FIG.2—THE PENCIL POINTS to one of three empty module locations on a Sandstar disk controller board. Any of the available modules will fit any location.

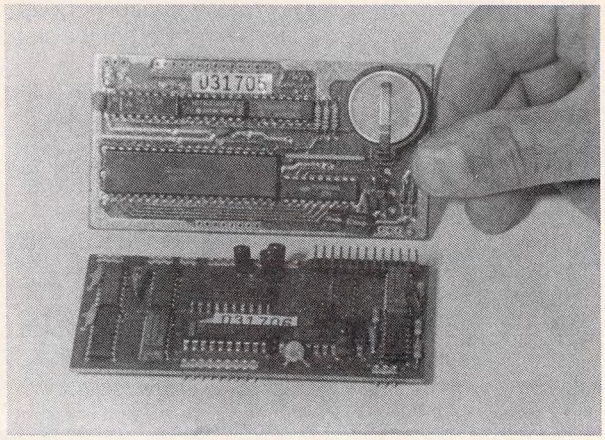

FIG.3—THE CLOCK/CALENDAR MODULE (top) is non-volatile because it is powered by its own on-board rechargeable battery. Like the parallel printer module (bottom), it plugs directly into the disk controller board.

least two, possibly three slots. The extra position on our Sandstar controller was used for a battery-powered clock/calendar. We actually had four functions in a single slot. (Because of recent IBM price cuts for their disk controller, we anticipate third-party controllers will be discounted for additional savings.)

Still more computer power

Before you run out to purchase your hardware, stop and reflect on what kind of system you'll want to end up with. Will you want a RAMdisk—memory that can function as a disk drive? For that you'll need extra memory and the software. If all you need is extra RAM you can get just a memory expansion adapter from IBM, assuming you have an available slot.

On the other hand, a board called the *Captain,* from Tecmar, Inc. (6225 Cochran Rd., Cleveland, OH 44139) provides the extra memory as well as serial and parallel ports, and a battery clock/calendar. But be careful not to duplicate existing functions. If you started out with a Sandstar disk controller you might already have the needed ports: You might only need extra memory, which is available as a separate memory-only board. To avoid the extra costs of duplicate functions, determine the kind of computer system you hope to end up with

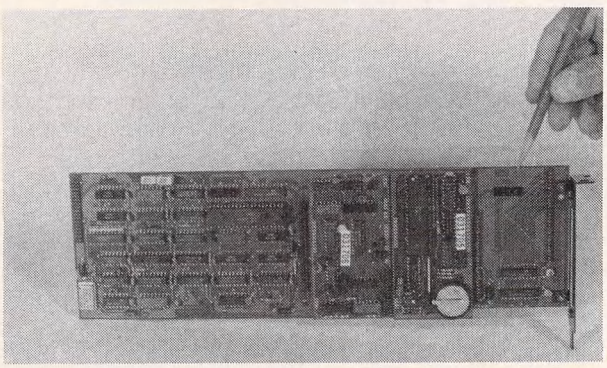

FIG.4—THIS IS HOW the disk controller board looks with the calendar/clock and parallel printer adapter installed. The pencil points to the remaining module location, which can be used for a serial I/O, another parallel port, or a game port.

before you make any purchases. If you think you'll want or need the extra memory, use the Tecmar board with its serial and parallel ports, and the basic (no ports) Maynard disk controller, or the IBM controller—which is a best buy at $100. There are several other sources for memory/port/calendar boards, among them Quadram and AST. More or less, they offer the same features: extra memory, serial and parallel ports, a game (paddle) port, and a battery-powered clock/calendar. An extra "plus" for the non-IBM multi-function boards is that they are usually supplied with a "free" software package that often includes high performance utilities. But there is software, and then there is *good* software.

For example, some of the "free" software which partitions part of RAM into a disk emulator (RAMdisk) simply assigns a drive letter to the partitioned memory. On the other hand, The Tecmar software lets the user substitute the RAMdisk for an existing drive, and then automatically moves the assignment of the existing drives up one notch: if the user assigns the RAMdisk as the B: drive, the software automatically makes the original B: drive into drive C:.

This doesn't sound like much, but if your software is always looking for a data file on drive B: it will default correctly if you copy the necessary files from what is now drive C: to RAMdisk B:. If the RAMdisk is any old assignment, software that defaults to B: will never work correctly out of the RAMdisk. (You can pull off the same trick using PC DOS 2.0 and 2.1, but it's easier if done automatically by the RAMdisk software.)

Software for multi-function memory boards also often permits the RAM to serve as a printer spooler. Again, there is software, and then there is *good* software. Some spooler software doesn't permit disk access for the foreground program while the spooler is in the background. Other software programs the extra RAM on the multi-function card to function as an independent spooler, allowing disk access by the foreground program. Make certain you understand exactly what you are getting in the way of spooler software. As a general rule of thumb, the multi-function boards are primarily super-high resolution graphics adapters, or memory boards with I/O ports, calendars and game ports. If you don't anticipate needing more than the basic 256KB of RAM it's questionable whether a multi-function board will be worth the money. You might be better off with a multi-I/O board—an adapter with any combination of up to four serial or parallel ports. Just eliminating the memory capacity (empty sockets) from a multi-function board can save $50 or more.

Putting it all together

We have wandered around a little to give you an idea of the kinds of savings to be made, and the various kinds of hardware available from third-party sources. It's now time to assemble our PC.

First things first. Take the cover off the bare PC by removing the six screws on the rear apron and sliding the cover forward. Then remove the covers for the disk drive compartments: simply pop the two speed nuts off the plastic posts on the rear of the covers. The RAM and other ICs used on the plug-in boards are extremely

sensitive to static voltage surges; any static elctricity in your body must be discharged to ground before you handle any components. Before you do anything else make certain you have a grounding bracelet connected from your wrist to a true electrical ground. If you don't have a grounding bracelet, make one by splicing a 1-megohm resistor in series with a length of wire, solder a small clip to one end of the wire and and connect the opposite end to the electrical ground. Attach the clip to your metal watchband, or the metal buckle if your watch has a leather or plastic band. If you don't wear a watch, make some provision to ground yourself because the RAM and the accessory boards usually lose their warranty if they are "blown" by static electricity. Handle nothing if you aren't grounded.

The next step in assembling your "cheaper and better" PC is to install the extra RAM into the empty sockets, making certain the notch on the end of the IC faces the rear of the chassis. Once again, we suggest you make 256KB of RAM the minimum configuration, so fill the three rows of empty sockets.

Next, install the graphics/monitor adapter in any slot except the one closest to the power supply and check out the computer before you install any other boards or accessories. (At each step of the way you must be certain the computer works before you go on to the next step). The monitor adapter installs the same as all the other boards: Select a slot, install the small plastic guide that's supplied with the adapter by simply pressing it into the matching holes on the front of the chassis, and seat the board in its slot. (Note, you must remove the matching slot cover on the rear apron before you seat the adapter in its socket.)

There are two internal DIP switches that must be set to correspond to the amount of memory and the number of disk drives. Remember, at this stage you have no drives. The instructions supplied with IBM's color/monitor board show how to set the switches.

Plug in the monitor and fire up the computer. If it works, install the disk drives and their controller board. The disk controller board must be installed in the slot nearest the power supply.

The standard controllers are supplied with the necessary connecting cables and notably excellent installation instructions, so there's no necessity to go into details here. Take note, however, that the cable is twisted at one of the two drive connectors: this is normal. It accommodates a clever system IBM used to avoid errors when programming each drive's disk selection jumpers.

Unike the programming of the drive-select jumpers for other computers, IBM programs both drives exactly the same with a "shorting bar" across drive select #2. Do not use any other shorting bars on the drive-select socket. Only drive A: uses a terminating "resistor block" that resembles an IC. Pull the block from the B: drive. Some disk suppliers such as CONROY-LAPOINT provide complete instructions on how to set up the drives.

Install the drives in their compartments. Secure any modules you plan to use with the controller on the disk adapter board along with all connecting cables, then install the controller in the last slot, the one immediately adjacent to the power supply. Connect the power plugs (part of the bare PC) to the drives, and then the ribbon cable from the controller. The cable goes to drive B: first; the end of the cable goes to drive A:. It might appear reversed but that's the way to do it.

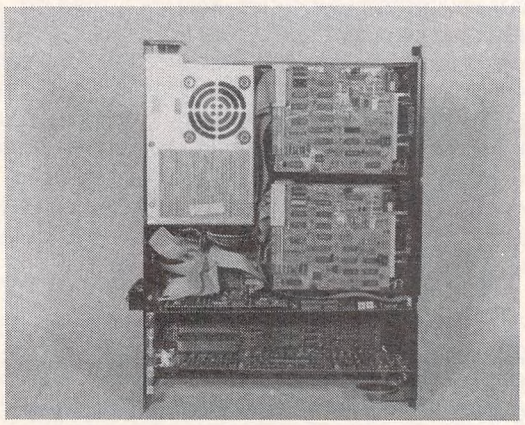

FIG.5—OUR MINIMAL DO-IT-OURSELVES configuration before further upgrading. The disk drives have been installed, along with the disk controller and graphics/monitor adapter boards. Both parallel and serial modules are installed on the disk controller card, which now provides four functions in a single slot. What appears to be a *rat's nest* of ribbon wire from the parallel and serial modules is just fine; don't try for neatness—Just position the wire wherever it will fit.

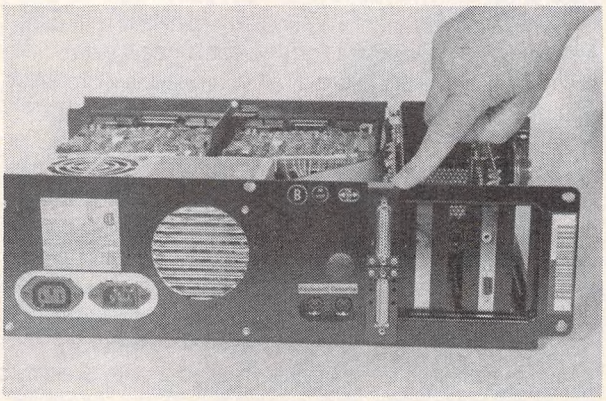

FIG.6—MORE SLOT CONSERVATION. The parallel and serial connectors are installed on a single mounting adapter to avoid "killing" a slot position just for a connector.

Set the DIP switches on the motherboard for two disk drives. Next, using IBM's DOS 2.0 or 2.1 (which you must purchase), check that everything works correctly. There will be a long delay after you turn the power switch *on* as the computer checks it's RAM. After what seems like an eternity (actually a few seconds), disk drive A: will start and load the DOS (*D*isk *O*perating *S*ystem).

If everything checks out, install your multi-function boards one at a time, testing every function before installing the next board. If you have done your planning carefully you will probably have every feature you want or need and still have at least one slot open for future expansion.◀CD▶